Sandia National Laboratories

Environmental Program

Subsurface Contaminants Focus Area SCFA

Subsurface Barrier Systems

Technology Need

The potential for groundwater contamination exists at old unlined hazardous waste sites. The remediation of these sites is often difficult, and sometimes impossible, using established technologies. Interim measures are necessary to mitigate contaminant movement until final remediation alternatives are developed.

Objective

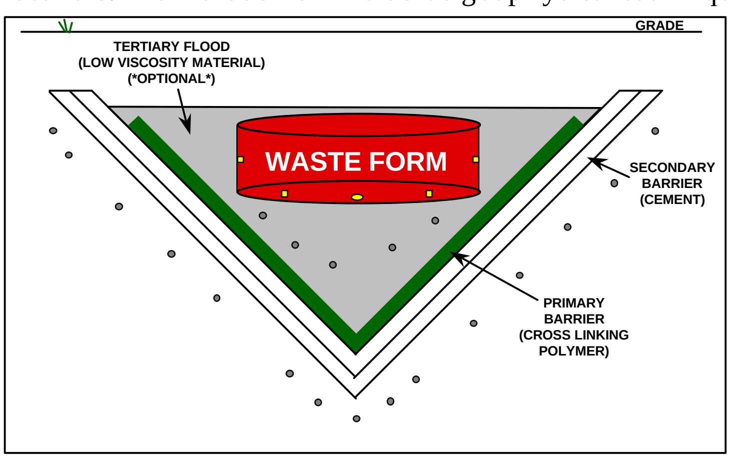
The Subsurface Barrier Emplacement Project has adapted vertical barrier equipment and technologies currently used in civil engineering applications to emplace horizontal barriers capable of confining leaking waste sites without disturbing the waste site to prevent the spread of contamination.

Project Description

Initially a variety of subsurface barrier emplacement technologies were considered for evaluation including: permeation, compaction, hydraulic fracture, and jet grouting; circulating-air-barrier; cryogenics; and the soil saw. Potential technologies were screened using the following criteria: cost, technical feasibility, applicability to varying geologic settings, and current state of development.

Two technologies, permeation and jet grouting, passed the screening criteria. Permeation grouting injects a low viscosity grout into the soil at low pressure, filling the voids without significantly changing the soil's structure or volume. In contrast, jet grouting injects grout at high pressure and velocity which destroys the soil's structure and mixes grout and soil to form a relatively homogeneous mass.

Permeation grouting was chosen first because of its low cost and relative simplicity. The permeation grouting experiment consisted of grouting in vertical and horizontal boreholes using multiple barrier materials. Numerous non-intrusive geophysical techniques used to identify where the grout flowed included crosshole seismic tomography, ground penetrating radar, electromagnetic induction, neutron probe, and downhole temperature logs. Finally, the grout site was excavated exposing the grout. Observations were compared with the crosshole tomography results. Comparisons were quite favorable, but the geophysical techniques were still limited. They can identify grout masses but not flaws in the continuity of the grouted soil. In summary, permeation grouting is only applicable to a site where a relatively



Conceptual Barrier Profile.

homogeneous, high conductivity region bound by lower conductivity regions exists beneath the waste site. Consequently, jet grouting, the second barrier emplacement choice, was evaluated.

The first jet grouting demonstration employed a variety of shapes using multiple materials. Installed configurations included: v-trough, cone, and rectangular monolith. Again, geophysical techniques were employed to image subsurface grout bodies. The geophysical results again indicated that current geophysical techniques are inadequate to verify the continuity of a grout barrier.

The second jet grouting demonstration involved emplacing a close-couple barrier beneath an existing simulated waste site. Two grouting materials (cement and a high molecular weight polymer) were used to form the composite, or close-coupled, barrier. The less expensive cement was used as the backdrop for the more expensive polymer lining. This dual barrier system provides cost savings by using concrete and, yet, still has the superior physical attributes, provided by the thin polymer lining, necessary to withstand nearly any waste form. Barrier verification included geophysical techniques, gas tracers, and liquid flood testing.

As a natural progression, a third field test using jet grouting was conducted at a “hot site” at Brookhaven National Lab (BNL) to exhibit all lessons learned to date. A v-trough shaped cemetitious barrier was emplaced beneath a mixed waste pit having approximate dimensions of: depth - 20 ft., width - 20ft., and length - 40 ft. Of great concern during this project was the location of a sole source aquifer supplying water to over 1.5 million people in New York; the aquifer surface was approximately 12 ft. beneath the bottom of the waste pit. Injection of the cementitious v-trough barrier progressed as expected. Next, a water proofing polymer (AC-400) was placed as a liner between the waste form and the cement v-trough forming a composite barrier. Finally, after curing of the composite barrier, the waste was stabilized using jet grouting at low pressure (~50 bars) to form a stabilized waste monolith. At the request of BNL EM-40 personnel, the large monolith was later fractured in situ into smaller more manageable units for disposal at a later date.

“Hot Site” Barrier Installation.

Advantages

The primary benefit of a subsurface barrier system is that the waste volume will remain fixed allowing additional time to develop remedial treatments. In addition, the remedial alternatives may be enhanced by the installed barrier, and the timing of cleanup becomes less critical.

Costs

A cost/benefit analysis for this barrier emplacement technology was completed in FY97.

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This effort is funded by the U.S. Department of Energy, Office of Science and Technology, through the Subsurface Contaminants Focus Area.

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